An in-depth look at scientific solutions to a real-world problem

Wildlife and Highway Management

Lesson 1: Is There a Problem with Wildlife on Our Roads?

LESSON OVERVIEW

Students must determine whether or not wildlife-vehicle collisions are a legitimate problem on which to spend money. They will be divided into small groups and given some data regarding this situation. Each group must analyze and present their data to the class. Then, each student will independently reach a conclusion and write a brief essay supporting it.

SUGGESTED GRADE LEVELS

- 7 – 12

ENDURING UNDERSTANDINGS

- Scientists often work in teams to solve problems.
- Accurate and reliable data need to be analyzed impartially to develop conclusions.

OBJECTIVES

Students will:

- Make a graph to represent numerical information.
- Analyze graphs to come to a conclusion.
- Write an essay in which their conclusions are supported by facts.

ARIZONA DEPARTMENT OF EDUCATION STANDARDS

Grade	Science	Mathematics	Writing
7	S1-C3-01; S1-C3-05; S1-C4-05; S3-C1-03; S3-C1-04; S3-C2-01; S4-C3-04	S2-C1-04; S2-C1-05; S2-C1-07; S2-C1-08; S2-C1-09	S2-C1-01; S2-C1-03; S2-C1-04; S2-C2-03; S2-C2-05; S2-C3-02; S2-C3-04; S2-C4-01; S2-C4-03; S2-C5-02; S3-C4-01
8	S1-C3-01; S1-C3-05; S1-C4-01; S1-C4-03; S1-C4-05; S3-C1-01; S3-C2-01	S2-C1-07; S2-C1-08	
High School	S1-C1-01; S1-C4-01; S1-C4-02; S1-C4-03; S1-C4-04; S3-C1-01; S3-C1-03; S3-C1-04; S3-C2-03	S2-C1-08; S2-C1-09	S2-C1-03; S2-C1-05; S2-C2-03; S2-C2-05; S2-C3-02; S2-C3-03; S2-C4-01; S2-C4-02; S2-C4-03; S2-C5-03; S3-C4-01

Note: The full text of these standards can be found in Appendix A.

TIME FRAME

- Two days (45 minutes each day)

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MATERIALS

- *Wildlife-Vehicle Collision Data Analysis* worksheets (one per group)
- Butcher paper (one per group)
- Markers
- Rulers
- *Is There a Problem? Rubric* (one per student)

TEACHER PREPARATION

- Make copies of the *Wildlife-Vehicle Collision Data Analysis* worksheets. Please note that there are six versions of this worksheet. Each group should get a different version. You might also want to make enough copies for each group member to have one.
- Make copies of the *Is There a Problem? Rubric* for each student.
- Gather enough materials for six groups.

SUGGESTED PROCEDURES

1. Divide the class into six groups of equal size. Number the groups, 1 through 6.
2. Hand out the *Wildlife-Vehicle Collision Data Analysis* worksheets.
3. As a class, read the information presented in the first three paragraphs. This will give the students a basic idea of what to expect.
4. Inform them that each group will be looking at the data concerning one small aspect of this whole situation. Each group must become experts on their part of the problem. After analyzing their data, they will be presenting the information to the class. Emphasize that they must pay attention to all of the presentations because they will use all of the information presented to determine what should be done, if anything, to prevent wildlife-vehicle collisions.
5. Let the groups work. Allow enough time for them to look at the data, graph it, and prepare their presentations. This will probably take the remainder of Day 1.
6. Ask each group in numerical order to make their presentation. Advise the students that they should take notes about important parts because they will be writing an essay on what they think should be done.
7. When all groups have presented, inform the students that they will now be working independently. Each student will write a brief essay summarizing the information that was presented by each group and coming to their own conclusion. They must first decide if there is a problem with wildlife-vehicle collisions, and, if so, what types of management measures can be used to control or prevent them. At this point, each student should be working independently. Hand out the rubric so that each student knows how the paper will be graded. Students who do not finish in the allotted class time may work on the essay as a homework assignment.

ASSESSMENT

- Group presentations
- Individual essay

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EXTENSIONS

- Have the students construct a graph using Excel and prepare their presentations using PowerPoint.

Appendix A: Arizona Department of Education Standards – Full Text

Science Standards

Grade	Strand	Concept	Performance Objective
7	1	3 – Analysis and Conclusions	1 – Analyze data obtained in a scientific investigation to identify trends 5 – Formulate a conclusion based on data analysis
		4 – Communication	5 – Communicate the results and conclusion of the investigation
	3	1 – Changes in Environment	3 – Propose possible solutions to address the environmental risks in biological or geological systems 4 – Analyze the environmental risks caused by human interaction with biological or geological systems
		2 – Science and Technology in Society	1 – Propose viable methods of responding to an identified need or problem
	4	3 – Populations of Organisms in an Ecosystem	4 – Evaluate data related to problems associated with population growth and the possible solutions
8	1	3 – Analysis and Conclusions	1 – Analyze data obtained in a scientific investigation to identify trends 5 – Explain how evidence supports the validity and reliability of a conclusion
		4 – Communication	1 – Communicate the results of an investigation 3 – Present analyses and conclusions in clear, concise formats 5 – Communicate the results and conclusions of the investigation
	3	1 – Changes in Environment	1 – Analyze the risk factors associated with natural, human induced, and/or biological hazards
		2 – Science and Technology in Society	1 – Propose viable methods of responding to an identified need or problem

Science Standards Continued

Grade	Strand	Concept	Performance Objective
High School	1	1 – Observations, Questions, and Hypotheses	1 – Evaluate scientific information for relevance to a given problem
		4 – Communication	1 – For a specific investigation, choose an appropriate method for communicating the results 2 – Produce graphs that communicate data 3 – Communicate the results clearly and logically 4 – Support conclusions with logical scientific arguments
	3	1 – Changes in Environment	1 – Evaluate how the processes of natural ecosystems affect, and are affected by, humans 3 – Assess how human activities can affect the potential for hazards 4 – Evaluate how urban development affects the quality of the environment
		2 – Science and Technology in Society	3 – Support a position on a science or technology issue

Mathematics Standards

Grade	Strand	Concept	Performance Objective
7	2	1 – Data Analysis (Statistics)	4 – Interpret data displays including histograms, stem-and-leaf plots, circle graphs, and double line graphs 5 – Answer questions based on data displays including histograms, stem-and-leaf plots, circle graphs, and double line graphs 7 – Interpret trends from displayed data 8 – Compare trends in data related to the same investigation 9 – Solve contextual problems using histograms, line graphs or continuous data, double bar graphs, and stem-and-leaf plots
8	2	1 – Data Analysis (Statistics)	7 – Formulate reasonable predictions based on a given set of data 8 – Compare trends in data related to the same investigation
High School	2	1 – Data Analysis (Statistics)	8 – Make reasonable predictions for a set of data, based on patterns 9 – Draw inferences from charts, tables, graphs, plots, or data sets

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Writing Standards

Grade	Strand	Concept	Performance Objective
7 – 8	2	1 – Ideas and Content	1 – Use clear, focused ideas and details to support the topic 3 – Develop a sufficient explanation or exploration of the topic 4 – Include ideas and details that show original perspective
		2 – Organization	3 – Place details appropriately to support the main idea 5 – Construct paragraphs by arranging sentences with an organizing principle (e.g., to develop a topic, to indicate a chronology)
		3 – Voice	2 – Convey a sense of identity through originality, sincerity, liveliness, or humor appropriate to the topic and type of writing 4 – Choose appropriate voice (e.g., formal, informal, academic discourse) for the audience and purpose
		4 – Word Choice	1 – Use accurate, specific, powerful words that effectively convey the intended message 3 – Use vocabulary that is original, varied, and natural
		5 – Sentence Fluency	2 – Create sentences that flow together and sound natural when read aloud
	3	4 – Persuasive	1 – Write persuasive text that: a) establishes and develops a controlling idea, b) supports arguments with detailed evidence, c) includes persuasive techniques, and d) excludes relevant information
High School	2	1 – Ideas and Content	3 – Provide sufficient, relevant and carefully selected details for support 5 – Include ideas and details that show original perspective and insights
		2 – Organization	3 – Place details appropriately to support the main idea 5 – Employ a variety of paragraphing strategies (e.g., topical, chronological, spatial) appropriate to application and purpose
		3 – Voice	2 – Convey a sense of identity through originality, sincerity, liveliness, or humor appropriate to the topic and type of writing 3 – Choose appropriate voice (e.g., formal, informal, academic discourse) for the application

Writing Standards Continued

Grade	Strand	Concept	Performance Objective
High School	2	4 – Word Choice	1 – Use accurate, specific, powerful words and phrases that effectively convey the intended message 2 – Use vocabulary that is original, varied, and natural 3 – Use words that evoke clear images
		5 – Sentence Fluency	3 – Demonstrate a flow that is natural and powerful when read aloud
	3	4 – Persuasive	1 – Write a persuasive composition that: a) states a position or claim, b) presents detailed evidence, examples, and reasoning to support effective arguments and emotional appeals, c) attributes sources of information when appropriate, d) structures ideas, and e) addresses the reader's concerns (grades 9 – 10) or acknowledges and refutes opposing arguments (grades 11 – 12)

Appendix B: Worksheets and Overheads

The pages that follow contain the worksheets listed below:

A. *Wildlife-Vehicle Collision Data Analysis* – Six different worksheets that present relevant information (6 pages)

B. *Is There a Problem? Rubric* – One method to evaluate student writing (1 page)

Wildlife-Vehicle Collision Data Analysis

Scientists have estimated that highway accidents kill between 500,000 and 700,000 deer in the United States every year.[1] These accidents can also result in injuries or death to humans as well as extensive property damage.

Many people believe that wildlife-vehicle collisions are a significant problem and millions of dollars should be invested to make roads safer for the humans that drive them and the animals that cross them. Other people disagree. Although they admit that accidents involving wildlife do occur, they believe that the problem is minor and our money is better spent elsewhere. You must take a careful look at the facts and come to your own conclusion.

Often in science, there is too much information for one person to analyze independently. As a result, scientists often work in teams. For this activity, your teacher will divide the class into six teams and provide each team with a piece of the data relevant to this problem. Each team must then analyze their data, prepare a graph and then present it to the class so that everyone becomes familiar with all the issues. To help your team be successful, each member will have to become an expert.

Group 1: Arizona Population

Use the table below to complete the tasks and answer the questions.

Table 1: Total Population of Arizona (in millions)

Year	1997	1998	1999	2000	2001	2002	2003
Population	4.6	4.8	4.9	5.1	5.3	5.5	5.6

Source: Arizona Department of Transportation

Tasks:

1. Use the data in the table above to make a line graph. Feel free to use large paper and markers to ensure that everyone will be able to see it.
2. Write a brief paragraph explaining what the graph shows. This will be the main information that your team will present to the class.
3. Answer the following questions:
    a. What is the total change in population over this time period?
    b. What is the average change in population per year?
    c. If this trend were to continue, what do you expect the population of Arizona to be in 2010? 2050?
4. Write a brief paragraph explaining what the graph shows. This will be the main information that your team will present to the class. Present your graph and your analysis to the class.
5. When all groups have presented, write a short essay (1-2 pages) in which you summarize the major facts and statistics, state whether or not the citizens of Arizona should be concerned about wildlife-vehicle collisions, and explain what action, if any, the Arizona government should take.

[1] Romin, L. A. and J. A. Bissonette. 1996. *Deer-vehicle collisions: status of state monitoring activities and mitigation efforts*. Wildlife Society Bulletin 24:276-283.

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Group 2: Statewide Wildlife-Vehicle Collisions

Use the table below to complete the tasks and answer the questions.

Table 2: Total Number of Vehicle Collisions Involving Wildlife in Arizona

Year	1997	1998	1999	2000	2001	2002	2003
# of Crashes	1285	1136	1480	1671	1638	1791	1414

Source: Arizona Department of Transportation

Tasks:

1. Use the data in the table above to make a bar graph. Feel free to use large paper and markers to ensure that everyone will be able to see it.
2. Write a brief paragraph explaining what the graph shows. This will be the main information that your team will present to the class.
3. Answer the following questions:
    a. Which year had the most collisions involving wildlife? The least?
    b. What is the average number of collisions per year?
    c. Does the number of collisions appear to be increasing, decreasing, or staying the same?
    d. If this trend were to continue, what would you expect the number of similar collisions to be in 2010?
4. Present your graph and your analysis to the class.
5. When all groups have presented, write a short essay (1-2 pages) in which you summarize the major facts and statistics, state whether or not the citizens of Arizona should be concerned about wildlife-vehicle collisions, and explain what action, if any, the Arizona government should take.

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Group 3: Injuries Resulting from Collisions

Use the table below to complete the tasks and answer the questions.

Table 3: Total Reported Injuries and Deaths from Vehicle Collisions Involving Wildlife in Arizona

Year	1997	1998	1999	2000	2001	2002	2003
Injuries	248	206	260	280	344	314	244
Deaths	2	7	2	2	1	3	5

Source: Arizona Department of Transportation

Tasks:

1. Use the data in the table above to make a bar graph. Feel free to use large paper and markers to insure that everyone will be able to see it.
2. Write a brief paragraph explaining what the graph shows. This will be the main information that your team will present to the class.
3. Answer the following questions:
    a. What is the total number of people injured over this time period? Killed?
    b. What is the average number of people injured/killed per year?
    c. Does the number of injuries/deaths appear to be increasing, decreasing, or staying the same? If this trend were to continue, what would you expect the number of injuries/deaths to be in 2010?
4. Present your graph and your analysis to the class.
5. When all groups have presented, write a short essay (1-2 pages) in which you summarize the major facts and statistics, state whether or not the citizens of Arizona should be concerned about wildlife-vehicle collisions, and explain what action, if any, the Arizona government should take.

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Group 4: Elk Population Near State Route 260

Use the table below to complete the tasks and answer the questions.

Table 4: Estimated Number of Elk in the Vicinity of State Route 260

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
# of Elk	1683	1678	1665	1672	1660	1710	1542	1716	1587	1488

Source: Arizona Game and Fish Department

Tasks:

1. Use the data in the table above to make a line graph. Feel free to use large paper and markers to ensure that everyone will be able to see it.
2. Write a brief paragraph explaining what the graph shows. This will be the main information that your team will present to the class.
3. Answer the following questions:
    a. Which year had the most elk? The least?
    b. What is the average number of elk per year?
    c. Does the population of elk appear to be increasing, decreasing, or staying the same?
    d. If this trend were to continue, what would you expect the number of elk to be in 2010?
4. Present your graph and your analysis to the class.
5. When all groups have presented, write a short essay (1-2 pages) in which you summarize the major facts and statistics, state whether or not the citizens of Arizona should be concerned about wildlife-vehicle collisions, and explain what action, if any, the Arizona government should take.

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Group 5: Elk Killed on State Route 260

Use the table below to complete the tasks and answer the questions.

Table 5: Elk Killed by Vehicle Collisions on State Route 260

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
# of Elk Killed	20	25	23	27	33	39	14	29	36	34	42

Source: Arizona Game and Fish Department and Arizona Department of Transportation

Tasks:

1. Use the data in the table above to make a bar graph. Feel free to use large paper and markers to ensure that everyone will be able to see it.
2. Write a brief paragraph explaining what the graph shows. This will be the main information that your team will present to the class.
3. Answer the following questions:
    a. In which year were the most elk killed? The least?
    b. What is the average number of elk killed per year?
    c. Does the number of elk killed by vehicles appear to be increasing, decreasing, or staying the same? If this trend were to continue, what would you expect the number of (or: collisions resulting in elk deaths) to be in 2010?
4. Present your graph and your analysis to the class.
5. When all groups have presented, write a short essay (1-2 pages) in which you summarize the major facts and statistics, state whether or not the citizens of Arizona should be concerned about wildlife-vehicle collisions, and explain what action, if any, the Arizona government should take.

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Group 6: Average Daily Traffic on State Route 260

Use the table below to complete the tasks and answer the questions.

Table 6: Average Annual Daily Traffic Volume (AADT) on State Route 260

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AADT	3124	3123	3652	3750	3950	4930	5112	4500	6267	8700

Source: Arizona Game and Fish Department and Arizona Department of Transportation

Tasks:

1. Use the data in the table above to make a line graph. Feel free to use large paper and markers to ensure that everyone will be able to see it.
2. Write a brief paragraph explaining what the graph shows. This will be the main information that your team will present to the class.
3. Answer the following questions:
    a. How much has the average daily traffic increased during this time period?
    b. What is the average increase in traffic per year?
    c. If this trend were to continue, what would you expect the average daily traffic to be in 2010? 2050?
4. Present your graph and your analysis to the class.
5. When all groups have presented, write a short essay (1-2 pages) in which you summarize the major facts and statistics, state whether or not the citizens of Arizona should be concerned about wildlife-vehicle collisions, and explain what action, if any, the Arizona government should take.

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Wildlife and Highway Management

Is There a Problem? Rubric

The following rubric will show you how your essay will be evaluated. Use it as you write.

CATEGORY	4	3	2	1
Accuracy of Facts (Content)	All supportive facts are reported accurately.	Almost all supportive facts are reported accurately.	Most supportive facts are reported accurately.	NO facts are reported OR most are inaccurately reported.
Adding Personality (Voice)	The writer has developed a unique and persuasive voice. There is a strong sense of personality.	The writer has developed a convincing voice. There is some sense of personality, but it may be inconsistent or weak at times.	The writer occasionally develops a convincing voice, but generally it is weak and inconsistent.	There is no sense of voice in the essay.
Sequencing (Organization)	Details are placed in a logical order, and the way they are presented effectively keeps the interest of the reader.	Details are placed in a logical order, but the way in which they are presented/ introduced sometimes makes the writing less interesting.	Some details are not in a logical or expected order and may distract or confuse the reader.	Many details are not in a logical or expected order. There is little sense that the writing is organized.
Word Choice	Writer uses vivid words and phrases that linger or draw pictures in the reader's mind, and the choice and placement of the words seems accurate, natural and not forced.	Writer uses vivid words and phrases that linger or draw pictures in the reader's mind, but occasionally the words are used inaccurately or seem overdone.	Writer uses words that communicate clearly, but the writing lacks variety, punch or flair.	Writer uses a limited vocabulary that does not communicate strongly or capture the reader's interest. Jargon or clichés may be present and detract from the meaning.
Flow and Rhythm (Sentence Fluency)	All sentences sound natural and are easy-on-the-ear when read aloud. Each sentence is clear and has an obvious emphasis.	Almost all sentences sound natural and are easy-on-the-ear when read aloud, but one or two are stiff, awkward or difficult to understand.	Most sentences sound natural and are easy-on-the-ear when read aloud, but several are stiff, awkward or difficult to understand.	The sentences are difficult to read aloud because they sound awkward, are repetitive, or difficult to understand.